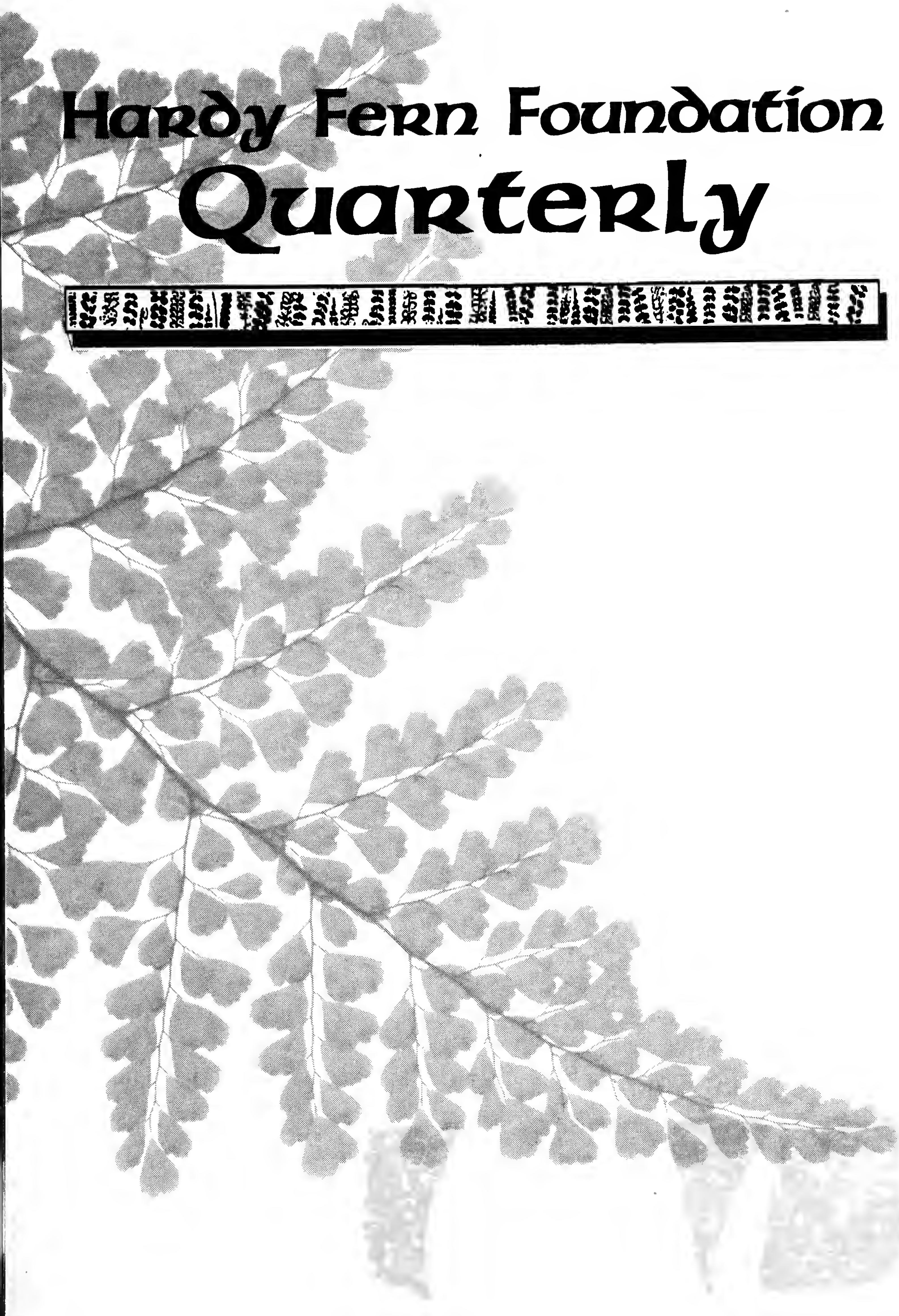
Hardy Fern Foundation Quarterly



THE HARDY FERN FOUNDATION

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The Hardy Fern Foundation was founded in 1989 to establish a comprehensive collection of the world's hardy ferns for display, testing, evaluation, public education and introduction to the gardening and horticultural community. Many rare and unusual species, hybrids and varieties are being propagated from spores and tested in selected environments for their different degrees of hardiness and ornamental garden value.

The primary fern display and test garden is located at, and in conjunction with, The Rhododendron Species Botanical Garden at the Weyerhaeuser Corporate Headquarters, in Federal Way, Washington.

Satellite fern gardens are at the Stephen Austin Arboretum, Nacogdoches, Texas, Birmingham Botanical Gardens, Birmingham, Alabama, California State University at Sacramento, Sacramento, California, Dallas Arboretum, Dallas, Texas, Denver Botanic Gardens. Denver, Colorado, Georgeson Botanical Garden, University of Alaska, Fairbanks, Alaska, Harry P. Leu Garden, Orlando, Florida, Coastal Maine Botanical Garden, Wiscasset, Maine, Inniswood Metro Gardens, Columbus, Ohio, New York Botanical Garden, Bronx, New York, and Strybing Arboretum, San Francisco, California.

The fern display gardens are at Lakewold, Tacoma, Washington, Les Jardins de Metis, Quebec, Canada, University of Northern Colorado, Greeley, Colorado, and Whitehall Historic Home and Garden, Louisville, KY.

Hardy Fern Foundation members participate in a spore exchange, receive a quarterly newsletter and have first access to ferns as they are ready for distribution.

Cover Design by Willanna Bradner.

THE HARDY FERN FOUNDATION

QUARTERLY

Volume 8 • No. 3 • Editor Sue Olsen

1998 Plant Distribution

The following ferns are available for fall shipment. Orders should be sent to Michelle Bundy, 1716 S. 223rd St., Des Moines, WA 98198. Orders must reach her no later than Friday Sept. 4. You will be billed at the time of shipping.

Cyrtomium fortunei - Zone 6 - 10, evergreen 18"-2'

Cyrtomium macrophyllum - Zone 7 - 10, evergreen, 18"-2'

Dryopteris affinis ssp affinis var. azorica - Zone 5 - 9, evergreen 2-3'

Dryopteris blanfordii - Zone 6 - 9, evergreen, 3'

Dryopteris crassirhizoma - Zone 5 - 8, evergreen, 2-3'

Dryopteris lepidopoda - Zone 6 - 9, evergreen, 2'

Dryopteris sieboldii - Zone 7 - 9, semi-evergreen, 2'

Dryopteris stewartii - Zone 6 - 9, semi-evergreen, 3'

Polypodium interjectum - Zone 6 - 8, deciduous, 1'

Polystichum neolobatum - Zone 5 - 9, evergreen, 2'

5.00 each

Montane Pteridophytes of Costa Rica with Dr. Alan Smith, January 8 - 18, 1999

Dr. Alan Smith is a research botanist and curator of ferns at the University of California, Berkeley Herbarium and an authority on tropical ferns and fern allies. His trip will concentrate on the higher elevations where pteridophytes reach their maximum diversity. The itinerary includes San Jose, Poas and Barva Volcanos, Brauliio Carillo National Park, Monte Verde Cloud Forest Reserve, El Valle Refuge Area, the Triangulo area, Arenal Volcano, Tabacon Hot Springs, Wildlife Refuge of Tapanti, Cuerici Biological Reserve and the Wilson Botanical Garden. Dr. Smith estimates that there are some 300-400 ferns in the areas to be visited with one site alone having over 150 types. Mateo Rutherford, a graduate student conducting research on the ecology and evolution of tree ferns at the Monte Verde Cloud Forest Reserve will also accompany the group as will a professional Costa Rican natural history guide. The cost per participant is $1,450.00 with a deposit of $250.00 per person due by August 15, 1998. For further information (the fine print) or to register contact Friends of the Jepson Herbarium, 1001 Valley Life Sciences Bldg. #2465, University of California, Berkeley, CA 94720-2465 or send an e-mail to Susan D'Alcamo at dalcamo@uclink4.berkeley.edu.

President's Message

Anne C. Holt, President

Welcome to spring and summer. Our mild wet weather continues causing rapid growth for most plants including our ferns. The slugs are especially prolific this year too. Be on guard.

The annual meeting of the Hardy Fern Foundation was held May 29th at the Center for Urban Horticulture amidst a splendid display of hardy ferns and associated plants that were for sale. This sale was in conjunction with the Northwest Horticultural Society and resulted in a net profit of $1762.00 for plants sold, including donations from Sue and Herman Entz and Sylvia Duryee, plus $1,000.00 as our share of the overall profits.

The slate of officers and board members was unanimously voted into office, starting a new year of the Hardy Fern Foundation. Following the meeting Don Jacobs of Decatur, Georgia showed slides from his garden and talked about his new book "Trilliums in Woodland and Garden - American Treasures". A record crowd enjoyed his lecture.

A large display of ferns have been planted at the Bellevue Botanic Garden. This is now becoming an important fern display garden.

A grant of $2,000.00 has been received from the Northwest Horticultural Society. This money will be used for signage in the renovated fern garden at the Rhododendron Species Botanical Garden. The fern garden continues to expand and the ferns are happy in this beautiful garden.

We welcome Whitehall Historic Home and Garden in Louisville, KY as our newest satellite display garden. We look forward to testing ferns in the area and offering their public an opportunity to see an assortment of ferns that are appropriate for local gardens.

Remember that your HFF membership entitles you to one free entry to the Rhododendron Species Botanical Garden. To receive your pass send a SASE to Sue Olsen, 2003 128th Ave. S.E.,Bellevue, WA 98005 and enjoy your visit.

Have a great summer. Keep 'ferning' and remember that in September ferns will be shipped to those members who have placed orders and to the satellite gardens.

Rhododendron Species Botanical Garden Appeal

Last year an anonymous donor gave the Rhododendron Species Botanical Garden a challenge grant of $400,000. that would be awarded if the membership and garden could match the donation. To date they have reached 87% of that goal. Time is running out, however, as the fund must reach 100% by the end of August of this year. Your donation of any size would be greatly appreciated. Checks should be marked "endowment" and sent to the RSBG at P.O. Box 3798, Federal Way, WA 98063-3798. As the garden houses the main collection of the Hardy Fern Foundation its long term health is very important to us as well. Thank you.

Dryopteris Dilatata

James R. Horrocks

This fern is commonly known by several names. In Europe and the British Isles it is called the Broad Buckler Fern. In North America it is known by such names as the Mountain Wood Fern, Mountain Shield Fern, Spreading Wood Fern, and Broad Wood Fern. As far as its botanical names are concerned, to quote Edgar T. Wherry: "The nomenclature of this taxon represents the worst comedy of errors among the ferns of (North America)". It has been listed under several species names: *Dryopteris austriaca* in Europe and *D. spinulosa* var. *americana* in eastern North America. More recently it has been equated with *D. expansa* (Lellinger), but according to Richard Rush, *D. expansa* is similar to *D. dilatata*, but smaller and synonymous with *D. assimilis* and *D. dilatata* var. *alpina*. The species name "dilatata" means "expanded" or "spreading", adding even more to the confusion. This species may be mistaken for any number of other closely related taxa but it is much larger in every way from those other species. It is often confused with *D. carthusiana* with which it may hybridize.

Reginald Kaye lists seven distinct varieties of this fern and this does not include the "Jimmy Dyce" variant or the "Recurved" form. In 1890, Lowe listed thirty seven varieties but most of them have been lost.

It is widely distributed in the northern hemisphere: Europe, Asia, North America, and even Greenland. In Japan, Iwatsuki again identifies it with *D. expansa*, but one look at the photograph will reveal that the two are really not the same. It is common in the British Isles, from sea level to alpine elevations. In North America, it is known from subarctic Canada down to northern New England and west to eastern Minnesota. It is widely disjunct further south and west. This fern frequents acidic deciduous or coniferous woodlands, with soil rich in humus. It may reach heights of four or even five feet in the wild.

Description: The rhizome is erect, forming a crown. The stipe is about two-thirds as long as the blade and clothed with large brown scales which may be darker in the centers. This species is deciduous, the thin-textured fronds from 2 to 3½ feet long, erect and arching. The fronds are two to three times divided, with the margins often turned under. The basal pinnae on the basiscopic side are noticeably longer. The innermost lower pinnule is as wide as the width of two upper pinnules. The overall frond shape in mature plants is broadly lance-shaped or even oval. The color is a deep rich green, occasionally blue-green. The sori are small, kidney-shaped, and arranged in rows. The indusium is small, without hairs or scales, or much less often glandular.

Culture: This species is rather easily grown in the garden, as long as the soil remains cool and moist. It is very ornamental and quite adaptable, being a rather vigorous grower. The soil should be rich in organic matter and kept a little on the acidic side if it is to really thrive.

Cultivars or varieties of this species include 'Crispa Whiteside', 'Cristata', 'Grandiceps', 'Jimmy Dyce', 'Lepidota cristata', and 'Recurvata'. Kaye also mentions a remarkable form "succisa" with large abruptly truncated pinnae and very narrow fronds.

This is a magnificent species, well worth having in the woodland garden, prompting many comments and compliments.

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Hardy Ferns, (1968) Reginald Kaye, Faber and Faber LTD, London

Ferns for American Gardens, (1994) John T. Mickel, MacMillan Publishing Co., New York

The Fern Guide, (1961) Edgar T. Wherry, Double Day, New York

Welcome New Members

Arlene Bell
Andrea Cioffi
Ruth Croasdill
Jeffrey H. Cross
Patricia A. Faller
Suzanne Gibbo
Vera Holm
Edy Horwood
Kayie F. Martin
Jack A. Northrop
Roman Pavela
Burton E. Randall Jr.
Joyce Ringquist
Paul Sable
Elizabeth Scott-Graham
Tom Scroggins
Milan Skulec
Carl Strohmenger
Mary Anne Thorton

THE HARDY FERN FOUNDATION
QUARTERLY

The Hardy Fern Foundation Quarterly is published quarterly by the Hardy Fern Foundation, P.O. Box 166 Medina, WA 98039-0166.

Articles, photos, fern and gardening questions, letters to the editor, and other contributions are welcomed!

Please send your submissions to
Sue Olsen
2003 128th Ave SE,
Bellevue, WA, 98005.

Newsletter:

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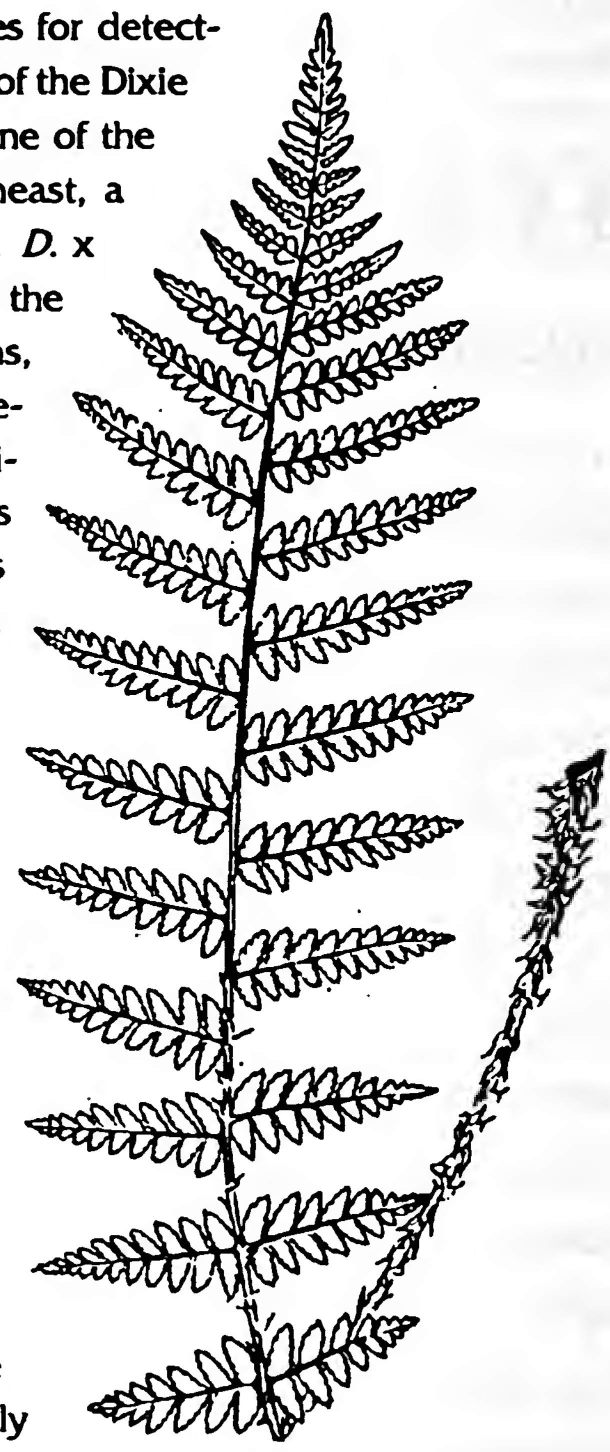
Assistants: *Janet Dalby, Sylvia Duryee, Sue & Herman Entz*
Graphics: *Willanna Bradner (cover design) Karie Hess (inside design)*

Producing Fern Hybrids for Hardy Garden Cultivation

Warren Herb Wagner - Department of Biology and Herbarium,
University of Michigan, Ann Arbor, MI 48109

It is hard to believe that nearly one-fourth of the kinds of ferns that are growing wild in North America are of hybrid origin. To be true, many of the hybrids are rare and hard to find. Many years ago I decided to find out how many of our ferns are of hybrid origin. My professor at the University of Pennsylvania was Dr. Edgar T. Wherry, one of the best field pteridologists in the world, a man with unbounded energy for exploring and sharp eyes for detecting species and hybrids. He was the discoverer of the Dixie Woodfern hybrid, *Dryopteris* x *australis*, now one of the most popular hardy garden ferns in the Southeast, a plant comparable to Mickel's Woodfern hybrid, *D.* x *mickelii*, a showy specimen for the gardens of the northeast. In my own studies, the holly ferns, *Polystichums*, of the northwest were given special attention and I was able to show that the California Holly Fern was a fertile hybrid, as well as Kruckeberg's and Western Holly Ferns. Tracy's Maidenhair Fern, *adiantum* x *tracyi* (A *jordanii* x *pedatum*) turned out to be an excellent hardy fern in Mrs. Carlotta C. Hall's garden in Berkeley, California. One of my favorite garden ferns in the northeast is the famous Rugg's Hybrid Royal Fern, *Osmunda* x *ruggii*. Florence Wagner and I discovered the only known wild population in existence today. It was growing in the Jefferson National Forest. However, I understand that offsets of plants from our garden are proving to be excellent hardy garden plants in the northeast. Dr. John Mickel has suggested that its propagation by gardeners might be speeded up by using a technique such as tissue culture. The point is that Rugg's Royal Fern, like so many hybrids, has abortive spores that mostly do not germinate successfully.



Dryopteris x *boottii*

The fact that many hybrid ferns are incapable of normal reproduction does not necessarily dictate that they cannot serve as vigorous and handsome garden plants. Another important point to make about hybrid ferns is that they are often more vigorous than either of the parents. A famous example of this is Boott's Hybrid Woodfern, *D.* x *boottii*. Its parents are Crested Woodfern, *D. cristata* and Glandular Woodfern, *D. intermedia*. Patches of Boott's Woodfern are noted for their ability to

persist in gardens. Another very successful woodfern showing hybrid vigor is the cross between the American Male Fern, *D. filix-mas* and the Marginal Woodfern, *D. marginalis*; so vigorous is the hybrid that even in nature it forms large, robust stands. Sometimes the hybrid gets into American nursery stock and is sold as Male Fern, which it tends to resemble more than its other parent.

Although there have been a number of fern hybridists in Europe, especially in England, there have been few in the United States. In my opinion the two most outstanding ones in the States were Margaret Slosson of Vermont and Kathryn "Kay" Boydston of Michigan. Slosson recognized the scientific value of hybridizing; she wrote "The study of hybridity in ferns promises to solve many problems presented by puzzling 'finds' of collectors, and open up a wide field for investigation of absorbing interest." (Slosson 1908)

It is hard to believe that Slosson, born in 1874, did her hybrid work in her twenties, over a century ago. (See Literature Cited for references.) She may be the first person ever to have deliberately crossed two fern species and worked out a technique to do this. The big issue of that time was whether Scott's Spleenwort, *Asplenium* x *ebenoides* was a hybrid (what we today would call a "nothospecies") or an ordinary species (an "orthospecies"). The British naturalist Rev. M.T. Berkeley was apparently the first to suggest seriously that it might be a hybrid (Weatherby 1949; Walter et al. 1982). Not only did Slosson experimentally synthesize *A. ebenoides* by producing cross-fertilization of the Ebony Spleenwort, *A. platyneuon* and the Walking Fern, *Asplenium (Camptosorus) rhizophyllum* (Slosson 1902) but she made the hybrid between two well-known woodferns, the Crested Woodfern *D. cristata* and the Marginal Woodfern *D. marginalis (Slosson 1899, 1900).* The latter hybrid combination was a well-known outdoor fern in New England and its synthesis was a milestone in the study of the genus now so popular in hardy fern cultivation. Slosson was associated with the New York Botanical Garden and lived in that area, but took her summers in Pittsfield, Vermont, where she must have seen many woodfern hybrids. She, like so many pioneers, has received little recognition for her work, although E.T. Wherry in 1942 gave the hybrid binomial *Dryopteris* x *slossonae* to *D. cristata* x *marginalis* in her honor.

Kathryn E. Boydston (1897 - 1988) was the fern hybridist know to many gardeners mainly during the years 1950 through 1975. She was originally a resident of Chicago, but she and her husband had a beautiful summer home along the St. Joseph River near Buchanan, Michigan. She was the person who developed the famous gardens at Fernwood, until recently a nature center popular with hardy plant gardeners. Finally, the Boydstons came to live there exclusively.

Kay, as she was called, had the good fortune of having natural mossy limestone tufa rock cropping out along a stream, where she could grow such winter hardy ferns as the American Hart's-Tongue, *Phyllitis scolopendrium*, and the beautiful little Maid-

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enhair Spleenwort *Asplenium trichomanes.* She became interested in spleenwort hybrids and began a program of hybridizing them in a little greenhouse attached to her house. She ended up making hybrids between hybrids! One of her favorite hybrids was the Wall Rue, *Asplenium ruta-muraria* x Scott's Spleenwort, the fertile hybrid of the Ebony Spleenwort x the Walking Fern. In other words, she created "tri-hybrids." Some of them involved the Hart's-Tongue. She also made backcrosses, the most interesting of which was Scott's Spleenwort backcrossed with the Ebony Spleenwort. This was especially remarkable because the backcross was discovered in nature only after its artificial synthesis in cultivation. In honor of Kay Boydston, Kerry S. Walter named the backross hybrid *A.* x *boydstoniae.* It was discovered in the wild at the famous Scott's Spleenwort locality at Havana Glen, Alabama, growing together with its parents.

By now, I hope that readers will appreciate what one can do in hybridizing ferns artificially. As a matter of fact, I believe that we are only beginning. Here and there in the U.S. and Canada, I hope to see people interested in culturing and growing ferns turning to creating new and different types for the greenhouse and outdoor garden. The point to emphasize is that there are almost infinite opportunities for innovative new ferns. Imagine my excitement when I discovered along a trail in Kauai, Hawaii, eight plants of a spontaneous intergeneric hybrid: *Lindsea ensifolia* x *Odontosoria chinensis.* No two ferns, it would seem, could be more different. The offspring is weird, a peculiar combination of the characters of the parents. We did not remove the plants from the wild. They are still there, so far as I know. (If everything remains stable, ferns in general are theoretically immortal, living and growing forever.) I remember the beautiful woodfern hybrid that Florence Wagner found at Mountain Lake in Virginia. On repeated visits to the locality over 20 years, from the early 1960's to the 1980's--we were teaching a fern course at the University of Virginia Biological Station--we would demonstrate the plant to our students and take a frond or two; it did not seem to mind. The hybrid was a glorious combination of Goldie's Woodfern, *Dryopteris goldiana*, and the Glandular Woodfern, *D. intermedia.*

The Hawaiian *Lindsae* x *Odontosoria* hybrid we named x *Lindsaeosoria*, a hybrid genus. My fascination with the potentialities of artificial hybridization was then further stimulated by an extraordinary hardy temperate hybrid originally discovered by rangers in Canada. This is the outrageous find in the Georgian Bay region of Ontario of the natural hybrid of a Woodfern and a Holly fern--*Dryopteris* x *Polystichum.* We (Florence, Tony and Susan Reznicek, Joe Beitel, and I) discovered five plants in three localities in two counties, always in the presence of the two, very unlikely parents, Goldie's Woodfern, *D. goldiana* and Northern Holly Fern, *Polystichum lonchitis* (Wagner et al. 1992). It is actually a beautiful fern but we do not know yet how it might fare in the fern garden as no plants were removed, of course. Because of its

unique origin we have named this hybrid fern x *Dryostichum singulare.* Remember: this is a chance natural hybrid. What could we do if we actually set out to artificially create more of these fascinating genetic combinations? All it takes is a little time and patience (and sometimes sheer luck).

I suspect that in choosing fern parents beforehand we should have in mind whether we are aiming for outdoor rock garden or soil-grown hardy hybrids. Most of the popular temperate garden ferns are simply terrestrial, growing on soil on the ground. These, even the truly wintergreen species, usually become dormant and the leaves become more or less marcescent (i.e., they hang on the plant but turn all or mostly brown). These plants must be winterized. They need the cold months to undergo the proper hormonal shifts. Rock ferns are, for the most part, different in that they do not require winterizing. For example, most spleenworts and rock brakes can be grown continuously indoors, both summer and winter. What I have done for limestone rock ferns is to plant them in soil-filled crevices of a limestone wall. I have seen beautiful rock ferns growing on artificially assembled rock habitats in hardy fern gardens. Kay Boydston's tufa allowed her to use the natural calcareous outcrops, but other gardeners have been successful both in the east and the west (e.g. Fred and Roberta Case, and the Kruckebergs respectively). There is no reason why an artificial limestone boulder habitat cannot be reconstructed (especially in a shaded, not-too-dry site) out of doors. I have had trouble, however, with hard acidic rocks like some sandstones, quartzites, schists, and granites.

The principles of cross-breeding ferns are very simple and there are many variations on how it may be accomplished. We are concerned with the following:

1. Washing fronds selected to be a source of spores under strong running water to remove contaminant spores
2. Finding a soil substrate medium
3. Placing medium in dishes or other containers, allowing for drainage
4. Sowing the parental spores
5. Growing gametophytes from spores
6. Preventing unwanted same-species fertilization from occurring by keeping culture dry or without free-flowing droplets or film of water
7. Causing fertilization to occur between species
8. Growing early stages of the resulting progeny
9. Establishing the later stages in the hardy garden

The fern life cycle is very simple. Spores are produced by the mother plant in the spore cases (sporangia). The spores, because of a special type of cell division called meiosis undergo a reduction of chromosome number from 2n or diploid, involving

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two sets of chromosomes (like people) to n or haploid, involving only one set (like our sperms and eggs). So if a fern plant has 44 chromosomes (like *Osmunda*) its spores will have 22. The sexual plant (gametophyte or prothallium) has only 22, but it has two types of sex organs--male (called antheridia) and female (called archegonia). These tiny organs produce sperms and eggs respectively. The egg stays in place in the archegonium, but if it is suddenly wetted the archegonium will open at the top and allow the now free-swimming sperms to swim in the water and enter. Once in the archegonium the sperm fuses with the egg to produce a 2n fertilized egg, and it is from this that the new fern plant grows. Ferns differ from most animals in having a separate stage, the gametophyte, in which fertilization takes place. In animals there are only sperms and eggs.

When we make hybrids we worry about the gametophytes of the prospective parents simply fertilizing themselves and thus giving rise to pure cultures of parents and no hybrids at all. The way we prevent this is to try to get fertilization to take place between gametophytes of *different stages.* A typical fern usually at first produces a few gametophytes with archegonia, a substance (antheridiogen) is produced that makes the other near gameotophyes all male. So, for example, when Kay Boydston made her various hybrids, she would have gametophyte cultures of one parent planted in one month and of the other a month or more later. The older cultures finally become bisexual or even all female, but the younger are almost 100 percent male. This is all well and good if we can keep fertilization from taking place. The method is quite simple: just keep any free water, film or droplets from forming in the culture dish. Keep the dishes humid, using covers, but do not water at all. When the time comes to actually make the hybrids, simply wet both cultures slightly and transplant the small male gametophytes into the cultures of large and more developed female gametophytes.

You can, of course, sometimes make hybrids simply by throwing spores together, but the most reliable and efficient way to hybridize ferns is to use cultures of the parents of different ages as described here. You increase the chances of hybridization tremendously. You will hear constantly from fern researchers that many ferns are inbreeders, but actually most inbreeders, occasionally do outbreed, or there would not be any fern hybrids. When you consider that about one-fourth of all the approximately 450 North American fern and fern ally taxa are of hybrid origin, you must admit that a lot of outbreeding has taken place. Look at the number of hybrids that we see already in hardy gardens (e.g. Mickel 1994). Some people have hardy gardens made up of all *Dryopteris* hybrids (e.g. D.J. Hagenah in Birmingham MI and Florence & Herb Wagner in Ann Arbor) and there is currently a *Dryopteris* hybrid garden at the Matthaei Botanical Gardens of the University of Michigan.

For a prothallium growing medium, you can use your favorite soil. Florence Wagner was very successful with a store-bought "African violet soil." It is not necessary to

sterilize soils if you are just after gametophytes for crossing purposes. In fact, sterilizing soil can sometimes cause more problems than not sterilizing it, because killing the majority of the soil microorganisms can cause an "epidemic" of one or the few of them that survive. This is troublesome when you are growing gametophytes.

Sowing the spores is a problem only when they become too crowded. The best procedure is to sow them in moderate numbers, well scattered over the substrate surface. The spores are best grown under moderate light, and the container (whether a glass bowl or plastic tub without a top) can be covered with plastic wrap. If the cultures are kept fairly dry and the temperature does not fluctuate (e.g., from day to night), the eggs in one culture and the sperms from the other parent can be kept from fertilization. When the time is ripe, the male gametophytes can be transferred by tweezers or in small clumps of soil to the other culture among the females. After placing many male gametophytes on the surface, using a dropper, the whole culture with now an irregular mixture of both cultures can then be wetted, and fertilization will take place.

The young ferns are yet to come, but ordinarily it takes patience to learn whether or not your cultures are going to yield hybrids. You need to prick out the young 2n sporelings and plant them individually. Kay Boydston used to plant them in rows in rich soil in flats; making it possible to spot the "odd balls" sooner--the individuals that showed intermediacy between the two parents. Those that are simply repeats of the respective parents can be removed, and special attention be given to the now synthesized hybrids.

There are many variations on the basic theme described here. Dr. Wherry told me long ago that some workers in the past had cut prothallia into strips and then laid them down together, one sex of one parental species on top, and the other (the other parental species) on the bottom. Another very clever technique that has been used depends on agar as the substrate--agar with either a simple chemical nutritional additive, or possibly, agar with a soil solution additive. In this case, the cultures are in glass petri dishes with transparent tops and bottoms. After the agar has been poured, cooled off, and jellied, the spores can be scattered on the surface and then the whole dish is turned upside down! Light is turned on from below. Back of this strange arrangement is the idea that in this way you can keep free water from falling on the gametophytes. Any water droplets that might form on the culture are quickly absorbed in the agar--so there is no free water and no unwanted fertilization until the grower is ready to make the hybrids. There are probably all sorts of different arrangements, some better, some worse. You may come up with a procedure better than those I have described.

Success in making interspecific (or intergeneric) crosses cannot be anticipated beforehand. Each species has its own compatibilities and incompatibilities with other

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species. However, there is no question that exciting and remarkable results can be obtained. Unexpected hybrid combinations may yield excellent plants for hardy fern gardening. And even if they are not successful cultigens, they may be interesting for other reasons. Who would have expected hybrids between *Dryopteris* and *Polystichum*? Who knows what you can devise experimentally. Are you game?

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American Horticultural Society Plant Heat-Zone Map

H. Marc Cathey, AHS President Emeritus

Most gardeners are familiar with the U.S. Department of Agriculture's Plant Hardiness Zone Map. By using the map to find the zone in which you live, you will be able to determine what plants will "winter over" in your garden and survive for many years. That map was first published in 1960 and updated in 1990. Today nearly all American reference books, nursery catalogs, and gardening magazines describe plants using USDA Zones.

But as we all know, cold isn't the only factor determining whether our plants will survive and thrive. Particularly during seasons of drought, we are all aware of the impact that heat has on our plants. And although there is still disagreement in the scientific community on this issue, many believe that our planet is becoming hotter because of changes in its atmosphere.

The effects of heat damage are more subtle than those of extreme cold, which will kill a plant instantly. Heat damage can first appear in many different parts of the plant: Flower buds may wither, leaves may droop or become more attractive to insects, chlorophyll may disappear so that leaves appear white or brown, or roots may cease growing. Plant death from heat is slow and lingering. The plant may survive in a stunted or chlorotic state for several years. When dessication reaches a high enough level, the enzymes that control growth are deactivated and the plant dies.

Using the Heat Map

Use the AHS Plant Heat-Zone Map in the same way that you do the Hardiness Map. Start by finding your town or city on the map. The larger versions of the map have county outlines that may help you do this.

The 12 zones of the map indicate the average number of days each year that a given region experiences "heat days" - temperatures over 86 degrees (30 degrees Celsius). That is the point at which plants begin suffering physiological damage from heat. The zones range from Zone 1 (no heat days) to Zone 12 (210 heat days).

In coming months, you will see the heat zone designations joining hardiness zone designations in garden centers, reference books and catalogs. On each plant there will be four numbers. For example, a tulip may be 3-8, 8-1. If you live in USDA Zone 7 and AHS Zone 7, you will know that you can leave tulips outdoors in your garden year-round. An ageratum may be 10-11, 12-1. It can withstand summer heat throughout the United States, but will overwinter only in our warmest zones. An English wallflower may be 5-8, 6-1. It is relatively cold hardy, but can't tolerate extreme summer heat.

Gardeners categorize plants using such tags as "annual" or "perennial," "temperate" or "tropical," but these tags can obscure rather than illuminate our understanding of exactly how plants sense and use the growth-regulating stimuli sent by the environment.

Many of the plants that we consider annuals - such as the petunia, coleus, snapdragon, and vinca - are capable of living for years in a frost-free environment. The

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American Horticultural Society Plant Heat-Zone Map ***continued from page 57***

Heat Map will differ from the Hardiness Map in assigning codes to "annuals," including vegetables and herbs, and ultimately field crops as well.

It will take several years for a majority of our garden plants to be coded. After almost 40 years, we are still perfecting the zone ratings for the Hardiness Map. Plants vary in their ability to withstand heat, not only from species to species but even among individual plants of the same species! Unusual seasons - fewer or more hot days than normal - will invariably affect results in your garden. And even more than with the hardiness zones, we expect gardeners to find that many plants will survive outside their designated heat zone. This is because so many other factors complicate a plant's reaction to heat.

Most important, the AHS Plant Heat-Zone ratings assume that adequate water is supplied to the roots of the plant at all times. The accuracy of the zone coding can be substantially distorted by a lack of water, even for a brief period in the life of the plant.

Although some plants are naturally more drought tolerant than others, horticulture by definition means growing plants in a protected, artificial environment where stresses are different than in nature. No plant can survive becoming completely desiccated. Heat damage is always linked to an insufficient amount of water being available to the plant. Herbaceous plants are 80 to 90 percent water, and woody plants are about 50 percent water. Plant tissues must contain enough water to keep their cells turgid and to sustain the plant's processes of chemical and energy transport.

Watering directly at the roots of a plant - through drip irrigation for instance - conserves water that would be lost to evaporation or runoff during overhead watering. In addition, plants take in water more efficiently when it is applied to their roots rather than their leaves. Mulching will also help conserve water.

There are other factors that can cause stress to plants and skew the heat-zone rating. Some of them are more controllable than others.

Oxygen. Plant cells require oxygen for respiration. Either too much or too little water can cut of the oxygen supply to the roots and lead to a toxic situation. You can control the amount of oxygen your plant roots receive by making sure your plants have good aeration - adequate space between soil particles.

Light. Light affects plants in two ways. First, it is essential for photosynthesis - providing the energy to split water molecules, take up and fix carbon dioxide, and synthesize the building blocks for growth and development. Light also creates heat. Light from the entire spectrum can enter a living body, but only rays with shorter wavelengths can exit. The energy absorbed affects the temperature of the plant. Cloud cover, moisture in the air, and the ozone layer - factors we gardeners can't control - affect light and temperature. But you can adjust light by choosing to situate your plant in dappled shade, for instance, if you are in its southernmost recommended heat zone.

Daylength. Daylength is a critical factor in regulating vegetative growth, flower initiation and development, and the induction of dormancy. The long days of sum-

mer add substantially to the potential for heat to have a profound effect on plant survival.

In herbaceous perennials and many woody species, there is a strong interaction between temperature and daylength. This is not a controllable factor in most home gardening situations.

Air movement. While a gentle spring breeze can "cool" a plant through transpiration as it does us, fast moving air on a hot day can have a negative effect, rapidly dehydrating it. Air movement in a garden is affected by natural features such as proximity to bodies of water and the presence of surrounding vegetation, as well as structures such as buildings and roads. You can reduce air circulation by erecting fences and planting hedges.

Surrounding structures. If the environment is wooded, transpiration from trees and shrubs will cool the air. On the other hand, structures of brick, stone, glass, concrete, plastic or wood will emit heat and raise the air temperature. Gardeners wanting plants to produce early or survive in cold zones will often plant them on the south side of a brick wall. Obviously, this would not be a good place for a plant at the southern limit of its heat zone!

Soil pH. The ability of plant roots to take up water and nutrients depends on the relative alkalinity or acidity of the soil. Most plants prefer a soil close to neutral (pH7), but there are many exceptions, such as members of the heath family, which prefer acidic soil. The successful cultivation of any plant requires that it be grown in a medium within a specific pH range. While it is possible to manipulate the pH of soil with amendments, it is easier to choose plants appropriate to your soil type.

Nutrients. Plants vary greatly in the ratio and form of elements they need for consistent, healthy growth. When these are present in appropriate quantities, they are recycled over and over again as the residue of woody material and dropped leaves accumulates and decays, creating sustainable landscapes.

How the map was created

The data used to create the map were obtained from the archives of the National Climatic Data Center. From these archives, Meteorological Evaluation Services Co., Inc. in Amityville, New York - which was also involved in the creation of the Hardiness Map - compiled and analyzed National Weather Service (NWS) daily high temperatures recorded between 1974 and 1995. Within the contiguous 48 states, only NWS stations that recorded maximum daily temperatures for at least 12 years were included. (Due to the amount of missing data in Alaska and Hawaii, the 12-year requirement was reduced to seven years at several stations.)

Because they were too difficult to map, data from weather stations at or near mountain peaks in sparsely populated areas were not incorporated. A total of 7,831 weather stations were processed; 4,745 were used in plotting the map.

For more information

Durable full-color posters of the AHS Heat Map are available for $14.95 each.
To order call (800) 777-7931 ext. 45.

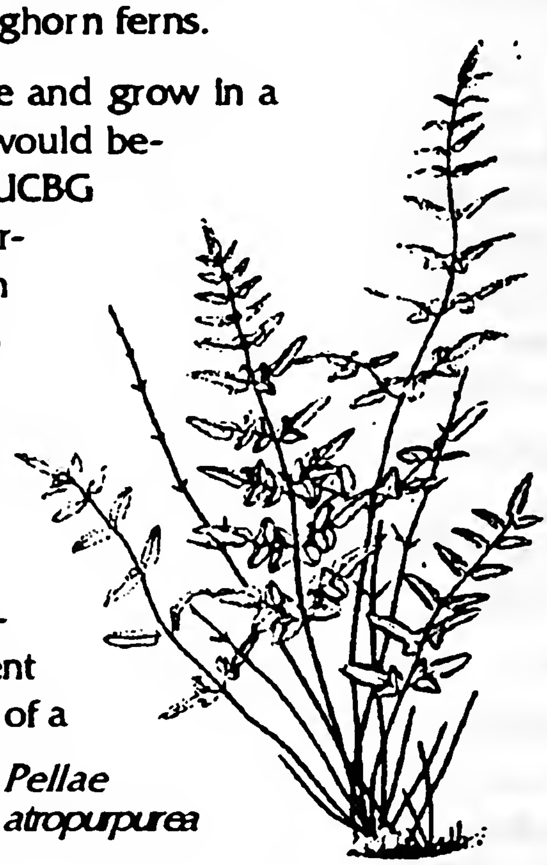
In January 1998, Time Life Inc. published a book on heat-zone gardening by H. Marc Cathey.

Xerophytic Ferns at UC Berkeley Botanical Garden
THE APPEAL OF FERNS

Martin Grantham

I am among those with a special fondness for ferns. They are the masters of form in foliage. Morphologists have questioned the homology (identity by descent) between the fronds of ferns and the leaves of flowering plants (hence the parallel terminology of stipe/frond and petiole/leaf) but if fronds are not leaves, then leaves have been outdone! The range of color and form is spectacular. The elegant combination of black lacquer stipes with new blades of flamingo pink found in the tropical *Adiantum macrophyllum*, or the fiery iridescence of the temperate Doodia aspera, hacksaw fern, approach the excesses of flowering plants. Form varies from the frothy, impressionistic *Adiantum raddianum* 'Gracillimum,' with its ultra-fine dissection through the bold integrity of *Asplenium* nidus, birds nest fern, to the modernist asymmetries of *Platycerium*, the genus of staghorn ferns.

Ferns have greater potential for horticultural use and grow in a wider range of situations than most gardeners would believe. Many exceptional ferns "put to the test" at UCBG have shown they can perform well in difficult garden situations. *Blechnum penna-marina* has been a very successful edging plant and ground cover, standing up to occasional foot traffic and producing thick mats that inhibit weeds. Some, like *Microlepia platyphylla*, have shown a tolerance for the heavy root competition of large trees. Others, like *Mildella intramarginalis*, can perform beautifully in dry shade. Still others, like the elegant *Aleuritopteris argentea*, are perfectly content growing between the stones on the vertical face of a rock wall.



Pellae atropurpurea

FERNS THAT BREAK THE STEREOTYPES

Especially intriguing among ferns grown at UCBG are the ferns from dryer environments, the ferns called variously rock, desert, or xerophytic ferns (for their habitat) or cheilanthoid ferns (for an appearance like that of the genus *Cheilanthes*, the lip ferns.) These names refer to several related genera in the family *Pteridaceae*, a family including the wet-growing maidenhair ferns as well. The xerophytic ferns have representatives distributed widely over the globe, but are particularly diverse in the American Southwest and Mexico. When I first learned of these ferns I thought: Why do they bother? Don't flowering plants do much better at this sort of thing? These ferns do show a more limited range of adaptations for dry habitats. None have developed succulence in any of their parts. The rhizome is generally thin and wiry with no capacity to store water and the roots remain, as in most ferns, delicate threads laid down by a single meristematic apical cell.

It is the aerial portions of these ferns that show many adaptations we think of as making plants better suited to dry habitats. In *Pellaea* the fronds are often finely

dissected with leaflets, or pinnules, that are very small. This serves to reduce heating in bright sun, but also gives these tough ferns a very delicate appearance. The leaflets are of heavy substance with a waxy cuticle and strongly recurved margins designed to conserve water. *Notholaena* shows heavy wax production on the underside of the fronds, reducing transpiration and making for a startling chalky-white coloration beneath. *Cheilanthes* and *Astrolepis* are masters of pelage or hairiness. Protective hairs (one cell in width) or scales (more than one cell in width) may cover all portions of the fronds, giving them a silvery appearance. The scales on the underside of the fronds may be of a strikingly different color from those above, yielding contrasts between silver and cinnamon or silver and chocolate. Young fronds loose greater amounts of water and are more vulnerable to damage during dry periods. Many xerophytic ferns avoid this problem by entering a heat induced summer dormancy. Some xerophytic ferns, like *Mildella intramarginalis*, are desiccation tolerant, with a special physiology allowing for survival during extremely dry periods. At such times the fronds of *Mildella* curl up tightly as they dry, their fresh green color changing to a dull olive. To all appearances, they pass what plant physiologists call the "permanent wilting point" beyond which foliage cannot be revived. But in this case, if water becomes available in a reasonable length of time, fronds that appear lifeless may revive completely over two or three days. This ability is also highly developed in *Pellaea*. Small plants have withstood up to 5 years of desiccation in experiments. Another way to interpret some of the foliar characteristics of xerophytic ferns may be as adaptations to exposure rather than to xeric conditions per se. Xerophytic ferns generally grow in open, dry, rocky areas at middle elevations where they experience high levels of exposure with high light intensities, wide temperature fluctuations and potential desiccation of their aerial parts via wind. Alpine and coastal strand habitats are also characterized by extreme exposure and plants from these habitats share some of the same foliar features we have described for xerophytic ferns such as coverings of hairs or scales which serve to screen out or reflect excess light, insulate against temperature extremes and create a boundary zone of still air which reduces drying and chilling by wind. Such coverings may also serve as a moisture reservoir for the leaf as has been described for the leaf scales of high elevation lepidote rhododendrons.

REPRODUCTION

Reproduction by spores would hardly seem an advantage in dry regions. Yet this might in fact make xerophytic ferns better than flowering plants at finding the restricted microhabitats in otherwise dry terrain that provide enough water for establishment and completion of the life cycle. Spores are released in far greater numbers than the seeds of flowering plants and, because of their small size, spores are much more widely dispersed. If a particular rock formation is arranged in such a way that precipitation (rain or dew) is harvested and funneled to a favorable spot, it won't be long before these same rocks are insulating the roots and rhizomes of ferns from midday heat. (Rocks have been shown to provide a temperature reduction of up to 15 degrees F in the field.)

The spores produced by ferns from dry habitats tend to be deeply pigmented with phytomelanin, a pigment closely related to the melanin which protects our own skin

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from UV damage. They are long-lived in storage and probably relatively long-lived in nature. (For ferns in general there is a broad range of 'shelf life' from a matter of days in 'green spored' *Osmunda* to under a year for *Cyathea* up to a record of 70 years for *Plagiogyria*.) Although xerophytic fern spores may be exceptionally tough, the life cycle stage to emerge from these spores, the gametophyte or prothallus, is very delicate and tiny. It consists of a central pad with several cell layers and two lateral wings a single cell layer thick. At the growing tip there is a notch which gives the entire structure the shape of a heart. The life cycle role of the gametophyte, as the name indicates, is to produce gametes. The male gamete is motile and requires a continuous film of water in order to reach the sessile female gamete. Fertilization results in the development of the sporophyte (so named because it eventually produces the spores through meiosis.) The sporophyte is the stage that comes to mind for all of us when we think of a fern.

REPRODUCTIVE QUIRKS

At this point you may be asking yourself: How can these delicate, water-dependant life cycle stages and events occur under xeric conditions? Basically the answer is speed via accelerated development or the elimination of certain steps. Alternatively, some fern gametophytes, as in Pellaea, can enter a state of physiological "suspended animation" during dry periods. The only structural adaptation to dryer habitats I have noticed in the gametophytes of xerophytic ferns is the production of wax (*Notholaena, Argyrochosma* and *Pellaea*.) which may reduce water loss.

Accelerated development may allow all vulnerable life cycle stages to occur during a relatively brief and perhaps rare damp period. Among ferns in general there is a broad range for the minimum time required to progress from spore to sporophyte. Xerophytic ferns are among the fastest, producing sporophytes in as little as 6 weeks in my experience while slower ferns may require two years or more. To save time many xerophytic ferns simply skip fertilization. An embryo forms directly from the gametophyte's central pad of tissue. This is called "apogamy" which means "without gametes". Abnormalities in meiosis resulting in diploid spores makes this type of development possible. In *Pellaea* gametophytes may have the ability to survive long periods of extreme desiccation during which they are quiescent. This would allow development to proceed cumulatively over sporadic wet periods.

DEVELOPMENT OF A NEW GARDEN DISPLAY AT UCBG

With their beauty, interesting biology, relative obscurity among the general public and unknown horticultural potential, the xerophytic ferns had been targeted for a special display at UCBG over a number of years. Collection development among ferns of all kinds at UCBG has been aided by the presence of pteridologist Alan Smith working at the UC Berkeley Herbarium. But it was through the prodigious collecting efforts of former UCBG Horticulturist Sean Hogan that our holdings of xerophytic ferns burgeoned between 1991 and 1994. Sean placed a number of these ferns in UCBG's New World Desert plantings with good success. (It is delightful to see just how well most have performed as companion plants for cacti!) The greater part of the collection, however, was housed for some time in an area closed to the public. I felt these unique ferns which performed so well under "unfern-like"

conditions should be highlighted in a display of their own so that we might increase awareness and interest in these handsome plants, while at the same time learning more about their cultivation requirements.

The site chosen was somewhat controversial. There was doubt among UCBG staff that any plant, let alone ferns, could withstand the rigorous southwest exposure. The shallow, redwood planters then in place allowed a lethal buildup of heat in summer so that nothing so far attempted had performed well. From what I had observed in our New World Desert plantings and in nature, I thought the xerophytic ferns were worth trying if we could construct a more appropriate planter; deeper,

Cheilanthes tomentosa

larger with thick insulating walls and with rocks among which to place the plants. To make light of the dire predictions in the air I referred to my proposed display as "the fern frying pan." But I also incorporated flowering plants selected to reinforce and complement the adaptive strategies shown by the ferns, to provide visual interest and to hedge my bets.

A quick-draining soil mix was used with the following formula: 30% firbark compost, 30% coarse sand, 20% 3/8" granite gravel, 10% expanded shale, 10% fine river sand. An automatic subsoil irrigation system was installed to backup overhead hand watering. I had as much lichen-covered Sonoma field stone as my back could bear to place with the plants.

The genera of xerophytic ferns displayed includes: *Cheilanthes*, a large, widely distributed and diverse genus with well over 100 species, many of which are easy to

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grow. Especially successful at UCBG have been *C. bonariensis, C. buchtienii, C. eatonii, C. lindheimeri, C. myriophylla, C. pruinata* and *C. tomentosa.*

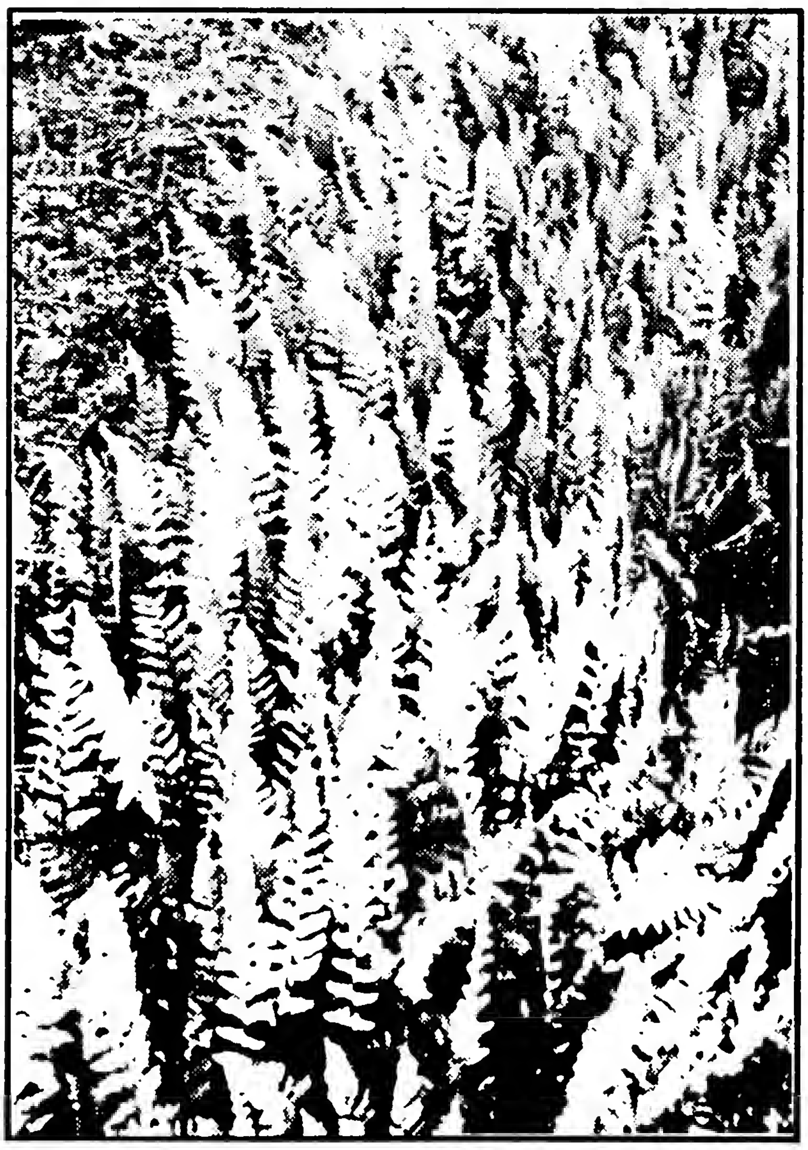
Astrolepis, a much smaller genus closely related to *Cheilanthes* with star-like branched hairs. A. sinuata has a wide range in nature and tolerates a wide range of light, soil and water conditions in cultivation.

Bommeria, a genus of only four species with beautiful pedate fronds that are raised just above the soil line. *B. hispida* would make an elegant ground cover with rhizomes that creep long distances and grow quite deep. The fronds can be damaged at temperatures below 25 degrees F but will be renewed from the deep rhizomes.

Notholaena, a genus of about 22 species which produce a waxy or farinose layer on the underside of the fronds that can be quite beautiful. This genus can be moderately difficult to grow. Most successful at UCBG has been *N. candida* and *N. copelandii.*

Argyrocosma, a genus of about 17 species closely related to *Notholaena* that also often produces chalky-white wax. The fronds are often much more finely divided than *Notholaena* with recurved margins as in many *Pellaea* species.

Pellaea, a genus of about 35 species with handsome, often very stiff, very finely divided fronds with a waxy cuticle and recurved margins. Especially successful at UCBG have been *P. truncata* and *P. atropurpurea.*



Cheilanthes. lindheimeri.
Photo by Martin Grantham

Fronds covered with silvery scales to 10", plants spreading slowly to form large clumps, hardy and tolerant of a wide range of soil types and watering practices but needs bright light and good air circulation. This plant has done well in both the Xerophytic Fern Display and in the New World Desert plantings.

Flowering plants originally featured included *Salvia cedrosensis*, which protects itself from exposure with a dense pubescence of branched hairs. It is a perennial subshrub rare in cultivation and endemic to Baja California Sur and Cedros Island. In summer the foliage is a bright, heat reflecting, white. It failed repeatedly during winters here when planted in our soils. The perfect drainage and harsh exposure of the fern display has allowed it to thrive through a rather wet winter, but occasional irrigation during the warm summer months has all but eliminated this plant from the display. We are left with several dwarf *Agave* species and a number of handsome *Echeveria* species which show a waxy bloom reducing water loss as in *Notholaena*. They also show leaf succulence, a trick beyond the ferns.

GROWING TIPS

In working with the xerophytic ferns it has become apparent many are among the easiest ferns to propagate from spores (given a little extra care in the early sporophyte stage during the transition to greater exposure.) Mature plants can also be divided with excellent success. They can be surprisingly adaptable as one can see by looking at the splendid specimens of *Cheilanthes lindheimeri* (from West Texas and Arizona in nature) thriving in both our New World Desert, with minimal summer irrigation, and our Eastern North American Section under regular irrigation. It is drainage, bright light and good air circulation that are the crucial requirements for good performance. Many go into dormancy with summer heat and grow in fall through spring, but protected in a lath house with regular watering most will grow year round. Because they come from seasonally dry areas where higher salt concentrations may be found in soils, they are more tolerant of salts than ferns from wetter habitats and can be fertilized more heavily.

Because xerophytic fern spores store well and require little space, it is very easy to back up our entire collection with stored spores. I routinely collect spore of all our desert ferns when they first become fertile. This proved very useful when two years ago we lost our single specimen of the infrequently collected *Pellaea mutabilis*. In this case I was able to produce a crop of 75 plants not only replacing the lost Garden accession, but allowing us to offer this unusual fern in future plant sales. Through the creation of a special display, plant sales and special distributions, I hope that these plants may be more widely grown and that the best may become readily available for garden use.

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Exploring Private Gardens in Europe Continued

Sue Olsen - Bellevue, WA

South American Blechnum penna-marina

On September 13, 1997 our hosts Dietrich and Sabine Nittritz filled our day to overflowing with more ferns and incredible gardens. We first visited their home and garden where as the accompanying article notes they have over 160 species and an impressive number of cultivars. Their collection of fancy *Athyrium filix-femina, Dryopteris* and *Polystichum setiferum* varieties rivals any we've ever seen. I particularly liked the *setiferum* assortment although a brisk wind restricted most of our efforts to photograph them. Even more impressive to me, however, were the hybrids (of which we were to see even more throughout the day) with the *Polystichums* being especially interesting. They included quite a number that have been created artificially by Dr. Anne Sleep and were a portion of the collection of the late fern scientist Prof. Tadeus Reichstein. Several of these have American natives in their parentage one of the most beautiful being *Polystichum proliferum* x *acrostichoides* (TR1751).

Their garden is quite compact and reflects their range of interests which in addition to ferns includes iris, rhododendrons (a handsome *R. roxieanum* was a standout), ground covers (a lovely *Saxifraga routundifolia*) and trees including an impressive specimen of *Acer griseum.* All of their plants are grown to perfection and set around the garden's lawn.

With so many ferns to see, it is hard to pick any particular ones for special mention, but I found a mat of dark green *Selaginella helvetica*, a plant I had never seen before extremely attractive. Their South American *Blechnum penna-marina* which is quite a bit larger than the New Zealand species we grow in the States (even acknowledging that ours are variable) was an eye-catcher with new growth the same ornamental intense red making the planting quite showy.

After a pleasant lunch (we were well fed at every stop), our entourage headed in the general direction of Denmark. Our first stop was at the Kiel Botanical Garden. Unfortunately, the rains had arrived but we enjoyed the ferns in their stunning conservatory. Here we were immersed in tree ferns, climbing ferns, and every sort of *Adiantum, Asplenium, Platycerium, Selaginella, Elaphoglossum, Psilotum* and to top it off *Equisetum giganteum* towering over us all.

We continued on to the home and family garden of Dr. Berndt Peters and what a garden it is - certainly one of the most comprehensive collections of ferns anywhere. Hardy species, cultivars and hybrids fill this large garden. In the latter classification I was amazed to find *Polypodium scouleri x glycyrrhiza* from our Pacific Northwest. (I'm looking for it in the wild now that I know it exists!!!) *Polypodiums* are clearly among Dr. Peters' favorites (his 1997 inventory lists 48 species and cultivars) and there were whole beds showcasing them. In addition, once again I found the *Polystichum* hybrids fascinating including a Pacific Northwest touch with *Polystichum braunii x andersonii*, and *P. andersonii x setiferum.*

Just about all of the garden is under cultivation and the emphasis is most certainly on ferns. I would guess that there must be close to or even more than 400 different types. Unfortunately the weather had really deteriorated with not only downpours but a generous dose of hail. (I did save a lot of money of film, however...would rather have the pictures.) One of my favorite "almost new to me" ferns of the entire trip was *Polystichum stenophyllum* a slender but leathery rock garden specimen. I had seen this some years ago in Reginald Kaye's garden, but didn't realize how handsome the new growth is until we ducked under cover from the rain and there it was with rich red new fronds on the order of *Dryopteris erythrosora.*

Not surprisingly, Dr. Peters does his own propagating and the greenhouse was in full production as was a lath house and several other shady areas. This is an ever expanding collection and most complete display of hardy ferns.

It was really a pleasure to see these gardens, meet the gardeners and learn about all the wonderful plant material they are growing. Our touring was wonderful and there's still morel

Mr. Nittritz Writes

I was born on July 23, 1936 at Woldenberg in Eastern Brandenburg. In 1945 my family was banished by the Polish Government so we moved to Schleswig-Holstein. In 1947 my parents bought a 1/4 acre lot in Eutin. Because of the lack of food at that time we cultivated potatoes, cabbage and carrots. As the economic conditions improved, I started to change the garden. I started with conifers from the Pacific Northwest (My brother has been a resident of Delta, British Columbia since 1954.) and some *Thuja plicata* are considerable trees now. I planted a lot of hardy perennials also. My special interest in ferns grew in 1987 while visiting the Hamburg Botanical Garden during a convention of the German Dendrological Society. I was impressed by the unrolling fiddleheads of *Polystichum setiferum* 'Plumosum Densum'. Later I became acquainted with Mr. Helmuth Schmick of Hamburg and his advice was very helpful. In recent years I collected many ferns in the United States, from Alaska to Kentucky as well as in Canada. Mrs. Judith Jones generously gave me many species and forms. Some of these did not survive our winters, for example *Dryopteris scottii, Polystichum lentum* and *Woodwardia fimbriata.* Now my garden is host to more than 160 species and 80 cultivars. Eutin is situated only 10 miles from the Baltic Sea and the hardiness zone is 7b.

Dr. Peters Writes

In 1960 my parents bought a piece of land. It was only a meadow without any trees and shrubs (and shade). Around 1968-70 we started to grow a few trees and with this my interest in plants began. I bought books about gardening and decided to study horticultural sciences at University.

It was especially the experience that some *Polypodiums* grew very well, even under trees with vigorous root systems, that my special interest in ferns began. I learned that the nurseries here have only a very few species and varieties so I contacted other fern enthusiasts, became a member of the British Pteridological Society and organized a few trips for some days to other countries and regions of Europe to meet other fern enthusiasts.....That's the history in a few words.

Polypodium Workshop

Wendy Born - Sebastopol, California

On the weekend of January 10-11th the Jepson Herbarium presented a workshop on the fern family *Polypodiaceae* led by Dr. Alan Smith. Dr. Smith has written the treatments for many of the fern families in The Jepson Manual-Higher Plants of California.

There are 500-600 species, and 25-30 genera worldwide of the *Polypodiaceae*. Most are tropical, but they also may be epiphytic or terrestrial in temperate zones.

Characteristics of the *Polypodiaceae* are:

Rhizome - usually long creeping, sometimes branched, has a vascular pattern know as a dictyostele, which means having discreet bundles in a ring, and the rhizome is dorsiventral which means there is a region where roots emerge, plus an area where leaves emerge.

Blades - simple, pinnatifid, or pinnatisect, also once pinnate, dimorphic - (sterile and fertile) fronds.

Indument - various types of both hairs and scales, hairs may be stellate, rhizomes almost always have hairs, scales may be peltate, clathrate.

Veination - highly reticulate and anostimizing, may have excurrent veination, recurrent veination, or to some degree both.

Sori - generally round or elongate, or achrosticholdes, exindusiate, paraphyses - possessed by most, these are structures in the sorus....hairs and glands.

Sporangia - long stalk, vertical annulus.

Spores - reniform, bilateral

Chromosomes - n +37, 36 Fronds abscise cleanly as there is an abscission layer. May leave a stalk remaining under this abscission layer. This stalk is a phyllopodium.

Gametophytes - persistent, branched.

These individual characteristics may not be unique to the *Polypodiaceae* and may be found in other fern families, but "all together" comprise the *Polypodiaceae*. At this point the *Polypodiaceae* is thought to be related to the *Grammitidaceae* as they share some characteristics, but the closest relatives are the *Davalliaceae*.

Some of the genera on display at the workshop either as potted specimens, herbarium samples, or in the greenhouses, or in cultivation in the U. C. Berkeley gardens were *Aglaomorpha, Belvisia, Campyloneuron, Colysis, Drynaria, Lecanopteris, Lemmaphyllum, Lepisorus, Microgramma, Pecluma, Platycerium, Pleopeltis, Phymatosorus,* and *Pyrrosia*.

The participants at the workshop were of various backgrounds and had various levels of fern knowledge. There were students, biologists, fern enthusiasts, and nursery people. The beauty of these Jepson workshops is that the participants can each pursue their particular interests... some of us attempted to write a basic key to the genera, or species of Polypodies, others focused more on viewing young gametophytes using dissecting scopes, while others wanted to know more on the process of staining and counting chromosomes.

This is the third fern workshop sponsored by the Jepson Herbarium and the classes are always excellent. They provide an outlet for fern people to learn from a person whose life work is ferns, and it seems that Dr. Smith enjoys sharing his knowledge with an inquisitive audience. It may also come to pass that several of the group members will form a loose "study group" and meet to discuss various fern topics...so the workshop indeed has proved to be most valuable.

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